REMARKS

Claims 15-27 are pending in this application. By this Amendment, claims 1-14 are canceled and claims 15-27 are added.

No new matter is added. Support for the new claims can be found in the original claims and present specification. For example, support for new claims 15-20 can be found in original claims 1 and 3-6, and paragraphs [0004], [0010], [0015], [0018] and Figure 1 of the present specification, support for new claim 21 can be found in paragraph [0015] and Figure 1 (dotted line 5), and support for new claims 22-27 can be found in original claims 7-14, and paragraphs [0018], [0019], [0020] and Figure 3 of the present specification.

I. Double Patenting Rejection Under 35 U.S.C. §101

Claim 2 was rejected under 35 U.S.C. §101 as allegedly claiming the same invention as that of claim 1 of U.S. Patent No. 6,719,148. This rejection is respectfully traversed.

Applicant has canceled claim 2. Accordingly, the present claims no longer contain a claim identical in scope to claim 1 in U.S. Patent No. 6,719,148.

For the foregoing reasons, Applicants respectfully submit that the double patenting rejection under 35 U.S.C. §101 should be withdrawn.

II. Rejections Under 35 U.S.C. §102(b)

A. Janovac

Claims 1, 3, 4 and 7-9 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by U.S. Patent No. 4,491,517 (hereinafter Janovac). The rejection is respectfully traversed.

New claim 15 recites a disc filter bag made of a solid-liquid separation filter cloth, new claim 20 recites a disc filter for solid-liquid separation that includes a filter bag made of filter cloth, new claim 22 recites a solid-liquid separation filtering module made of filter

cloth, and new claim 25 recites a drum filter for solid-liquid separation that includes a filtering module made of a filter cloth that is arranged on a filtering element.

Janovac discloses a screen for separating particles according to size. The screen is used to separate material in a machine that relies on gravity or a vibrating mechanism for separation. See column 1, lines 39 to 43 of Janovac. Further, the screen of Janovac is made of wires. Nowhere does Janovac disclose a disc filter bag or filter module made of cloth as recited in present claims 15, 20, 22, 25 and claims dependent therefrom.

Therefore, the structure of the disc filter bag, disc filter, filtering module and drum filter as recited in the present claims is different from the structure of the screen as taught by Janovac. Reconsideration and withdrawal of the rejection is respectfully requested.

B. Brushafer

Claims 1 and 3-10 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by U.S. Patent No. 5,843,542 (hereinafter Brushafer). The rejection is respectfully traversed.

Brushafer relates to a woven fabric sleeve to provide a protective or insulating covering over an elongated item, such as piping, wiring and other tubular shaped items. See column 1, lines 12-21 and column 3, lines 27-30. Nowhere does Brushafer disclose any filtering purpose of the fabric sleeve. That is because the protective fabric of Brushafter is not suitable for filtration due to its loose structure.

Brushafer is completely silent as to any filtering purpose, which is logical since the protective fabric presented therein is not suitable for filtering. The fabric of Brushafer uses alternating filamentary members to create empty spaces that function to result in increased flexibility of the fabric. Brushafer fails to disclose a filtering portion having a structure and density for separating liquid from a mixture consisting of solids and liquid. Thus, nowhere

does Brushafer disclose a disc filter, a bag for a disc filter or drum filter or a filtering module for a drum filter as in the present claims.

The Patent Office alleges that the coating of Brushafer is the same as the batt layer recited in claim 6 (new claim 19 that depends from claim 15), citing column 6, lines 22-35 of Brushafer. However, the coating in Brushafer is an epoxy material that is formed with a sleeve shape and heated to cure the epoxy. As such, the coating of Brushafer is only present on the surface of the fabric. On the other hand, the batt layer of claim 19 provides a solid-liquid separation fabric, which is attached to the fabric by needling. Needling provides for batt fibers not only present on the surface of the fabric, but also penetrated inside the fabric.

Therefore, the structure of the disc filter bag, disc filter, filtering module or drum filter as recited in the present claims 15-27 is different from the structure of the fabric sleeve as taught by Brushafer. Reconsideration and withdrawal of the rejection is respectfully requested.

C. Fischer

Claims 1, 3, 4, 6-9 and 11-13 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by U.S. Patent No. 5,180,409 (hereinafter Fischer). The rejection is respectfully traversed.

Fischer relates to a fabric for filtering particulate matter from a stream of hot gases, such as gases from exhausts of combustion engines. See the Abstract of Fischer. Fischer teaches a fabric that can trap large quantities of soot as mentioned in column 2, lines 16-17. As shown in Figure 1 of Fischer, small pockets are left between full yarns (16) that extend between support strands of each layer of the fabric (12). Figure 2 shows two tiny cells (18) between the fill and support yarns. Such pockets and cells can serve as traps for filtered particulate matter as mentioned in column 4, lines 45-51. As such, the fabric traps particles and is not capable of solid-liquid separation. Even if, for some reason, the fabric of Fischer

were arranged in a solid-liquid filtering apparatus, the fabric would need to be changed after every filtering step because the fabric would be clogged when the material is trapped inside the fabric. Thus, the fabric of Fischer is unsuitable for solid-liquid separation.

Moreover, Fischer mentions that gases pass radially inward through the layers of filtering fabric and perforations of the inner tube (see column 5, lines 7-9). In Figure 3 of Fischer, arrows (38) show the direction of the flow as transverse relative to the direction of the surface. As such, a filtered fluid would not flow between the filtering fabric and the tube of Fischer. Thus, Fischer fails to disclose a structure for separating liquid from a mixture consisting of solids and liquid.

Therefore, nowhere does Fischer disclose a disc filter, a bag for a disc filter or drum filter or a filtering module for a drum filter as in the present claims. Reconsideration and withdrawal of the rejection is respectfully requested.

D. Lumsden

Claims 1, 4, 7-9, 11 and 12 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by U.S. Patent No. 3,716,138 (hereinafter Lumsden). The rejection is respectfully traversed.

Lumsden relates to screens, and particularly to woven wire cloth in a vibratory screen used for classifying the material flowing through or over the screen. The vibrating screen of Lumsden is designed for classifying materials according to particle size, and is not suitable for solid-liquid separation as in the present application. Lumsden recites a screen and not a filter. The vibratory screen of Lumsden does not comprise a filtering portion having a structure and density for accomplishing solid-liquid separation. Thus, Lumsden does not disclose the solid-liquid separation filter cloth of the present claims and the screen of Lumsden is not suitable for disc filtering or drum filtering.

Further, Lumsden does not teach a filter that is arranged against any filtering element. Instead, Lumsden teaches a support with decks having a screen cloth 19 tensioned between tension plates 20 along opposite sides of the deck (see column 1, lines 63-65). Figures 2 and 3 clearly show that the screen is tensioned between the tension plates and that nothing is below the screen, and thus does not describe a filter cloth arranged against a filtering element as in claim 1.

Moreover, Lumsden discloses a wire screen having a symmetrical structure as shown in Figures 5, 8 and 11. The wires 26, 46 and 66 run on the upper surface side and on the bottom surface side in the screen. Thus, Lumsden does not provide thicker parallel yarns on the underside of the screen as in the present claims. Lumsden discloses warp wires 65 that are maintained in spaced parallel relation by weft wires 66 arranged in groups of three at spaced intervals along the length of the warp wires. Thus, Lumsden forms a so-called long slot screen and does not provide parallel channels as in claim 1. Between the groups of three wires 66 in Lumsden, there are only wires 69 and no wires in the same direction as the wires 66 (see Figures 10 and 11). The so-called long slot screen structure of Lumsden is very coarse, and thus would not be capable of solid-liquid separation.

Even if, for some reason, the screen of Lumsden were used for liquid-solid separation, the solids would easily pass through the screen and no separation would be achieved. The liquid and solids passing through the screen would not flow under the screen, but instead would easily return to the upper surface side of the screen. Lumsden does not disclose a filter cloth with channels wherein the sorted substance could flow as in the present claims.

Therefore, the structure of the disc filter bag, disc filter, filtering module or drum filter as recited in the present claims is different from the structure of the screen as taught by Lumsden. Reconsideration and withdrawal of the rejection is respectfully requested.

III. Rejections Under 35 U.S.C. §102(b)/103(a)

A. Fischer

Claim 14 was rejected under 35 U.S.C. §102(b) as allegedly being anticipated by, or in the alternative, under 35 U.S.C. 103(a) as allegedly being obvious over Fischer.

As discussed above, the fabric of Fischer includes pockets and cells that serve as traps for filtered particulate matter as mentioned in column 4, lines 45-51. As such, the fabric traps particles and is not capable of solid-liquid separation. Even if, for some reason, the fabric of Fischer were arranged in a solid-liquid filtering apparatus, the fabric would need to be changed after every filtering step because the fabric would be clogged when the material is trapped inside the fabric. Thus, the fabric of Fischer is unsuitable for solid-liquid separation.

Further, Fischer mentions that gases pass radially inward through the layers of filtering fabric and perforations of the inner tube. Figure 3 of Fischer, shows the direction of the flow as transverse relative to the direction of the surface. As such, a filtered fluid would not flow between the filtering fabric and the tube of Fischer. Thus, Fischer fails to teach or suggest a structure for separating liquid from a mixture consisting of solids and liquid.

For all the same reasons as discussed above, Fischer fails to teach or suggest a drum filter as in the present claim 27 (original claim 14). Reconsideration and withdrawal of the rejection is respectfully requested.

B. Lumsden

Claims 1, 4, 7-9 and 11-12 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by, or in the alternative, under 35 U.S.C. 103(a) as allegedly being obvious over Lumsden.

As discussed in detail above, Lumsden does not teach or suggest the solid-liquid separation filter cloth of the above claims. As such, the screen of Lumsden is not suitable for disc filtering or drum filtering. Lumsden instead relates to screens, and particularly to woven

wire cloth in a vibratory screen used for classifying the material flowing through or over the screen. Further, Lumsden does not teach a filter that is arranged against any filtering element.

For all the same reasons as discussed above, Lumsden fails to teach or suggest a disc filter, a bag for a disc filter or drum filter or a filtering module for a drum filter as in the present claims.

C. SE 431,826

Claims 1-14 were rejected under 35 U.S.C. §102(b) as allegedly being anticipated by, or in the alternative, under 35 U.S.C. 103(a) as allegedly obvious over SE 431,826.

An English language translation of SE 431,826 is attached, as requested by the Patent Office.

SE 431,826 relates to a filter element that includes fold filter sacks that is used for bright filtering of water polluted by leached horizon. The filter element with fold filter sacks is further described in German patent publication DE 1,249,826 (see page 1 of the specification of SE 431,826). DE 1,249,826 corresponds to English language GB 1,134,778, which is attached for the Examiner's convenience.

As shown in Figures 1-3 of GB 1,134,778, the fold filter sack is clearly different from a filter bag for disc filtering or a filtering element for drum filtering as in the present claims. Nowhere does GB 1,134,778 teach or suggest the filter bag for disc filtering or filtering element for drum filtering as in the present claims.

Instead, SE 431,826 discloses filter cloth for separating solid particles and liquid, comprising at least two interwoven layers: a filtering layer and a supporting layer. In the supporting layer, for example in the portion facing the filtering element, thicker yarns are used to achieve a coarser bottom. However, liquid that has already passed the filtering layer in the direction of the surface of the filtering element flows inside the supporting texture of

the filter cloth. The yarns form obstacles to an efficient flow of liquid because the texture comprises yarns traveling crosswise and having different directions.

On the other hand, the present application discloses a filter bag and filtering element that includes an underside of the filter bag that comprises substantially parallel yarns that are thicker than the rest of the yarns of the bag. The thicker yarns form parallel channels therebetween in order to enable the filtered liquid to flow in the direction of the surface of the filtering segment between the filtering portion of the filter bag and the filtering segment.

In SE 431,826, the filter sack is made of a filter cloth having a standard filter weave and a supportive weave connected to one another. The supportive weave does not disclose any parallel channels, which would serve as flow channels for separating a fluid. Thus, nowhere does SE 431,826 teach or suggest the filter bag for disc filtering or filtering element for drum filtering as recited in the present claims.

Therefore, SE 431,826 fails to teach or suggest a disc filter, a bag for a disc filter or drum filter or a filtering module for a drum filter as in the present claims.

V. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of claims 15-27 are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

Respectfully submitted,

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JAO:JBK/rav

Attachments:
English-language translation of SE 431,826
GB 1,134,778

Date: January 24, 2007

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SE 43 1826

FILTER ELEMENT

DESCRIPTION

The invention relates to a filter element comprising a filter sack, particularly a fold filter sack, and a load-bearing frame with frame sides articulately connected to each other, whereby tension members are arranged between two frame sides directed towards each other, and the upper frame side is formed as a filter outlet line.

Filter elements with fold filter sacks made of textile single weaves for bright filtering of liquids are known (German patent publication 1 249 826). As a rule, given standard woven fabrics are used, the filtering properties of which are adapted to the requirements of the filtering. The permeability (density) and quality of the weave play here an important role. In addition to cotton and wool, also synthetic woven fabrics are used, the chemical and thermal durability of which vary a great deal.

Filter devices with fold filter sacks function in such a way that the liquid to be filtered is taken under pressure into a filter chamber, where it comes into contact with the outside of a filter insert with the fold filter sack, penetrates through the filter cloth of the fold filter sack, accumulates as filtrate and is led out of the filter device as such.

The filter inserts serve essentially as support devices for fold filter sacks and must be shaped in such a way that the effective filter cloth surface, i.e. filter cloth's free surface that is not supported, becomes as large as possible with relation to the total filter cloth surface and does not provide any greater resistance to the filtrate flow. On the other hand, very narrow limits are set for the weave's tensile strength, depending on the filtering pressure and the desired permeability of the free filter cloth surface.

It is especially problematic to control the filtering capacity in filter devices with filter sacks made of weave filters and filter sack holders. In a known embodiment of this kind, the filter sack holder is rectangular and semi-rigid, whereby the four frame sides are articulately connected to each other and can be folded together to a flat bar. Between two opposite parallel frame sides, liquid-permeable tension members are arranged for a single or composite filter surface, and the uppermost frame side is formed as an outlet line for the filtrate. Such a filter holder can be folded together as Nuremberg scissors in such a way that it can, in the folded state, be taken into a filter sack

closed in all directions and having only one inlet opening, whereby the filter sack holder can be spread out into the work position inside the sack. With regard to the capability of folding together and leading the folded filter sack holder into a filter sack, the number and shape of tension members in these sack filter holders must be limited and adapted in a certain way. In a known filter sack holder, chains with interconnected, elastically shapable intermediate joints, such as tension members, are arranged, which are attached by one end to the frame side formed as a filtrate outlet line and by the other end to the opposite frame side, so that the tension members have the same direction as the main flow of the filtrate. In filter sacks with a filter surface one to several times larger, which, folded in a bellows-shaped manner, are pushed to the filter sack holder, there are the tension members in known embodiments in parallel with the folds of the sack filter. A sack filter constructed in such a way is not sufficiently expanded under high pressure and do not therefore provide great resistance to filtrate discharge, which decreases the filtering capacity significantly. These disadvantages are reduced with another known filter sack holder, the tension members of which are positioned in parallel with or at an angle of up to 45° to the filtrate discharge.

These and similar known solutions for increasing the filtering capacity are not, however, optimal, above all because they require filter inserts that leave only a relatively small, self-supporting and unsupported filter surface free, and they have a complex structure, require a lot of space and are difficult to maintain.

DE-PS 662 747 discloses a filter material, particularly for fuel filters in tung oil motors, comprising a double weave whose binding is, however, selected in such a way that the binding yarns are placed at the filter opening, so that the filter material seems smooth.

According to DE-AS 1 003 185, which relates to a filter plate apparatus, a protective grating with reinforcement function is provided, which will give the filter cloth mechanic durability. The binding takes place between supportive yarns, so that a supportive screen is formed.

DE-OS 1 461 499 relates to the use of a filter weave of two inseparably connected weave layers, of which one is coarse and strong and resistant to mechanic effects and the other is a fine weave for carrying out the actual filtering in filter presses. The aim is to increase the mechanic resistance in a filter cloth for filter presses, to which the use of a double weave known as

such contributes. It is not explained how the two weaves of the double weave are to be connected.

The object of the present invention is to increase the filtering capacity in filtering devices with filter sacks and to make it relatively independent of capacity-decreasing effects, particularly by tension members of the filter inserts.

The problem is solved according to the characterizing features defined in claim 1.

It is advantageous if the supportive weave is more coarse-meshed with the same yarn strength or a coarser weave of thicker yarns than the filter cloth weave, which gives especially good filtrate discharge.

In a particular embodiment of the invention, the filter cloth is a double weave comprising a standard filter weave, particularly of synthetic material, for instance polypropylene fiber yarn (staple fiber weave), and thus a weave-technically firmly connected supportive weave. The weave technique of both weaves may correspond to the same basic weave type, for example a satin, twill or plain weave; it is also possible to weave together fabrics of different bindings in one weave phase.

The supportive weave is suitably formed single-yarned of monofilament yarns having the same diameter. The elasticity of the monofilament yarns as well as the ratio between the number of warp and/or weft yarns of the filter weave and the number of warp and weft yarns of the supportive weave can be adapted to the desired filtering capacity. It has turned out, for example, that for bright filtering of water polluted by leached horizon, a double weave formed of a conventional staple fiber filter weave (polypropylene) and thus a weave-technically connected supportive weave of monofilament yarns with a diameter of 0.2 to 0.8 mm, preferably 0.4 mm, are suitable, whereby the ratio between the number of warp and weft yarns of the filter weave and the number of warp and weft yarns of the supportive weave is 2:1 to 6:1, preferably 3:1.

The double weave can be bound together via up-weave, down-weave, binding warp or binding weft. It is essential that the binding yarns do not change the structure of the filter weave so that for example holes would be formed that could result in turbid filtrate. The binding yarns must run under at least the outer surface of the filter weave and must not be pressed through.

Figures 1 to 3 show preferred filter cloths for a sack filter according to the invention, implemented as double weaves.

Figure 1 shows a filter cloth of a double weave connected through up-binding.

Figure 2 shows a filter cloth of a double weave connected with down-binding.

Figure 3 shows a filter cloth of a double weave connected through a binding warp.

The filter cloth according to the invention, shown in Figure 1, is formed of a filter weave 1 with warp yarns 3 floating over two weft yarns 2, and a supportive weave 4 formed of monofilament warp yarns 5 and monofilament weft yarns 6. The supportive weave 4 is connected to a filter weave 1 by means of monofilament yarn 5. Hereby, the up-binding point 7 of the warp yarn 5 is covered by the face warp yarn 3 positioned nearby. This gives the upper surface of the filter weave face-warp character, and prevents the monofilament yarn 5, which is raised to the upper weft yarn 2, from pressing through. It is sufficient that the up-binding is carried out repeatwise.

It is particularly advantageous if the filter weave 1 is connected to the supportive weave 4, as shown in Figure 1, in such a way that the filter cloth is formed of the filter weave 1 with weft yarns 3 floating over two warp yarns 2, and a supportive weave 4 formed of monofilament weft yarns 5 and monofilament warp yarns 6. Every sixth to tenth weft yarn 5 is formed of staple fiber yarn and is used for up-binding.

Figure 2 shows a filter cloth with down-binding according to the invention. It is formed of a filter weave 8 with upper warp yarns 9 floating over two upper weft yarns 10, and an under or supportive weave 11 with monofilament weft yarns 12 and monofilament warp yarns 13. Hereby, the upper warp yarn 9 is positioned deeply at the monofilament weft yarn 12, so that the down-binding point 14 is deeply in the filter weave.

Figure 3 shows a particularly advantageous embodiment of the invention. The filter cloth comprises a filter weave 15 with upper warp yarns 16, which float over two upper weft yarns 17, and a supportive weave 18 with monofilament weft yarns 19 and monofilament warp yarns 20. The diameter of the monofilament yarns is 0.4 mm. The filter weave 15 comprises staple fibers in a twill weave K 2/2, the supportive weave 18 comprising monofilament yarns in a plain weave L 1/1. The ratio between the number of warp and weft yarns in

the filter weave and the number of warp and weft yarns in the supportive weave amounts to 3:1. The two weaves are connected by a binding warp 21, preferably by staple fiber yarns, which also run in the plain weave L 1/1. In this way, neither warp nor weft yarn gets from the supportive weave into the filter weave, and thus no yarns in the supportive weave can press through the filter weave.

Figures 1 to 3 represent only three examples that have turned out to be particularly suitable for a certain polypropylene weave, but they can as well be used for other weaves, for example weaves made of perlon, dralon or cotton.

Since in the filter element according to the invention the filter weave does not come into direct contact with the supportive organ, the filtrate flow is restrained to a significantly smaller extent. It is possible to adjust the rigidity of the supportive weave together with the filter weave according to the filtering pressure. The weave according to the invention has also higher tensile strength than conventional filter cloths and withstands higher pressure and greater surface loads. It is, however, surprising that even at the same pressure the filtering capacity is significantly higher than in conventional filter cloths, which possibly depends on more favorable transportation of the filtrate. The filter cloth according to the invention is particularly suitable for separating solid components from liquids.

Filter sacks of filter elements according to the invention gives at the same pressure higher filtrate amounts than conventional weave filters, in particular fold filter sacks. The supportive weave functions approximately in the same way as an isolation layer between the actual filter weave and known filter inserts, such as special supportive bodies, and this results at the same filtering pressure in better outflow potential with relatively higher filtering capacity. It is naturally also possible to use, with good results, a three-layer filter cloth, where the filter weave is positioned in the middle and is connected to a supportive weave on both sides.

It has totally surprisingly turned out that the filtering capacity for filters with the frame size of up to about 500 x 500 mm can be increased even more if the tension members are left out and the fold filter sack of the filter cloth according to the invention is provided with the supportive weave towards the filtrate side on a rectangular semi-rigid filter sack holder, the four frame sides of which are articulately connected to each other.

Similarly, it has totally surprisingly turned out that at least the same filtering capacity can be achieved if inner supportive bodies are left out completely and the inner frames are replaced with an outer holder frame, which keeps the filter sacks in a work position in such a way that they are not changed by the effect of the filtrate flow. The frame can be rigid or semi-rigid with a filter sack attached and tensioned in the inside of the frame, whereby no special supportive bodies or tension members are arranged in the filter sack.

It becomes apparent from the above examples that the filtering capacity of a filter apparatus with the filter element according to the invention is significantly greater than for conventional filter devices.

Example

Four reference tests were made with the following differences.

In test 1, a filter bag or a filter sack was used without a supportive weave on a filter frame of the size of 500 x 500 mm without any extra tension members. In test 2 the procedure was the same but with a filter sack having a weave according to Figure 3, the filter weave of which corresponds to the weave in the filter sack according to test 1. The supportive weave was arranged on the outer slop side. In test 3, a filter sack similar to the one in test 2 was used but with the supportive weave arranged on the inner filtrate side, which was drawn over the supportive frame with extra horizontally arranged tension chains according to DT-PS 1 249 826. In test 4 the procedure was the same as in test 3 but the tension chains were left out, so that the primary supportive and tension effect was achieved only with the supportive weave.

The four different filter sacks or supportive frames were compared in exactly the same way with each other by connecting the elements to a tap water circulation with the same pump, the pump capacity being set from the beginning at 4.0 m^3/h with the pressure loss 0. During the repeated water circulation, the amounts of 200 g, 200g and 500 g of leached horizon were supplied successively, and after that filtering was carried out through all filter elements. The results become apparent from the table below.

	Final amount capacity	Pressure decline
Test 1	2.0 m^3/h	2.47 bar
Test 2	4.7 m^3/h	1.45 bar
Test 3	5.7 m^3/h	1.12 bar
Test 4	6.6 m^3/h	0.70 bar

The surprisingly great improvement in the amount capacity and pressure decline when a filter weave with a supportive weave was used becomes apparent from tests 3 and 4. Completely contrary to expectations, the results concerning the amount capacity and pressure decline are worse when extra tension members were introduced (test 3) than when such extra tension members were left out.

CLAIMS

1. A filter element comprising a filter sack, particularly a fold filter sack, and a load-bearing frame with frame sides articulately connected to each other, whereby tension members are arranged between two frame sides directed towards each other and the upper frame side is formed as a filter outlet line, **characterized** in that the filter sack comprises a filter weave (1), which is on the filtrate side connected with a supportive weave (4) of greater bending rigidity in such a way that the binding yarns (5) run under the surface of the filter weave (1).

2. A filter element according to claim 1, **characterized** in that the binding yarns (5) are covered by weave yarns in the filter weave (1), preferably through floating.

3. A filter element according to claim 1 or 2, **characterized** in that the filter weave (1) is connected to the supportive weave (4) through up-binding or down-binding, and that the up-binding or down-binding yarns are formed of the same material as the filter weave yarns.

4. A filter element according to any one of claims 1 to 3, **characterized** in that the ratio between the number of warp and/or weft yarns in the filter weave (1) and the number of warp and/or weft yarns in the supportive weave (4) is 6:1 to 2:1, preferably 3:1.

5. A filter element according to claims 1 to 4, **characterized** in that it is formed of the filter weave (1) with warp yarns (3), which float over two weft yarns (2), and the supportive weave (4), which is formed of monofilament warp yarns (5) and monofilament weft yarns (6), whereby the supportive weave (4) is connected to the filter weave (1) over monofilament warp yarns (5).

6. A filter element according to any one of claims 1 to 5, **characterized** in that the filter cloth is formed of the filter weave (1) of staple fiber yarns with weft yarns (3), which float over two warp yarns (2), and the supportive weave (4), which is formed of monofilament weft yarns (5) and monofilament warp yarns (6), whereby every sixth to tenth weft yarn (5) is formed of staple fiber yarns and used for up-binding.

7. A filter element according to any one of claims 1 to 4, **characterized** in that it is formed of the filter weave (8) with face warp yarns (9), which float over two face weft yarns (10), and the supportive weave

(11) with monofilament weft yarns (12) and monofilament warp yarns (13), whereby the down-binding takes place over the face warp yarn (9).

8. A filter element according to any one of claims 1 to 4, **characterized** in that it is formed of the filter weave (15) with face warp yarns (16), which float over two face weft yarns (17), and the supportive weave (18) with monofilament weft yarns (19) and monofilament warp yarns (20) as well as a binding warp (21), whereby the filter weave (15) is woven in twill weave (K 2/2), the supportive weave in plain weave (L 1/1), and the binding warp (21) run in plain weave (L 1/1).

9. A filter element according to any one of claims 1 to 8, **characterized** by a frame without a tension organ.

10. A filter element according to any one of claims 1 to 10, **characterized** in that the fold filter sack is attached and tensioned to a rigid or semi-rigid frame.

11. A filter element according to any one of claims 1 to 10, **characterized** in that the filter sack is formed of a threefold filter weave, whereby the filter weave is arranged in the middle and surrounded on both sides by a supportive weave.

PATENT SPECIFICATION 1,134,778

DRAWINGS ATTACHED.

1,134,778

Date of Application and filing Complete Specification:
7 March, 1967. No. 10650/67.

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Index at Acceptance:—B1 D(1B4, 2J1C1, 2J1D).

Int. Cl.:— B 01 d 29/14.

COMPLETE SPECIFICATION.

Improvements in or relating to Filter Supporting Elements.

I, WALTER SCHEIDT, of Dorner Weg 16, Wuppertal-Elberfeld, Germany, of German Nationality, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

Conventional plate, pocket or bag filters consist of containers made of suitable filtering materials, such as, for example, a textile fabric supported by suitable elements. Filtering takes place from the outside through the filter towards the inside, from which the filtrate is removed by suitable means.

There are known filter supporting elements which can be folded up after the manner of lazy tongs so that they can be inserted into a filter bag, equipped with an open neck or sleeve, and are again expanded after they have been inserted in this manner. Then it is only necessary to seal the narrow insertion passage or neck.

These foldable filter supporting elements make possible the use of filter bags, the length of which is a multiple of the length of the opened filter supporting elements. This excess bag length is folded after the manner of a bellows and pushed over the filter supporting element. A filter surface with vertically extending folds is formed and, although these folds are not spread, the folded filtering surface is fully effective if the filter supporting element has been suitably inserted.

In a known, frame-shaped and foldable filter supporting element with an integral filtrate discharge projecting laterally therefrom, the frame part is constructed in a particularly efficient manner. Between the top and bottom parts of the frame there are spaced vertically extending spreading means for the filter bag, consisting, for example, of rods, strings, chains or the like. Particularly chains or chain-like structures have been found useful, because these do not obstruct the removal of the filtrate from the interior of the bag, are sufficiently mobile and resilient during the opening out and folding of the element, and combine sufficient strength and durability with a comparatively small volume. Consequently a filter supporting element equipped with chains is not too heavy and unwieldy and occupies in the folded condition only a small volume, enabling it to be inserted through a comparatively narrow sleeve which can be easily sealed. In order to make for the tightest possible folded state, the permissible number of spreading elements is limited. In addition, the frame hinges must not be exactly at the corners but must be partly offset therefrom.

This known construction of a foldable filter supporting element with spreading means has the drawback that the vertically extending spreading means are parallel to the vertical main flow of the filtrate inside the bag and, with the use of the excess length type of filter bags. Since the number of spreadthe folds. Since the number of spreading means is limited for the reasons given above, gaps remain between the spreading means where, especially with higher flow velocities of the filtrate and with higher pressures, the sides of the bag are not sufficiently spaced apart and the flow of the filtrate inside the filter bag is obstructed.

This invention consists in a foldable frame-shaped supporting element, adapted for location inside a flexible filter-bag, comprising a four-sided collapsible frame whose sides are hinged together, with elongated spreading means, which allow passage of filtrate therethrough, extending between two opposite sides of the frame, wherein one side of the frame is in the form of a channel-like extension of an outlet pipe for discharge of the

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filtered liquid and the spreading means extend parallel to or at an angle of up to 45° to the said one side.

It has been found that by means of this different arrangement of the spreading means relative to the main filtrate flow, substantially better filtering properties are obtained. Comparison tests between the known vertical and the new horizontal filter spreading means of a corresponding number and construction, and under otherwise identical working conditions have shown an identical initial flow rate of filtrate of 6.73 m^3/hour with the same pressure loss of 1.35 kg/cm^2 in both cases. With increasing filter contamination which was the same in both cases, the filter flow rate of the known construction dropped to 2.5 m^3/hour with a pressure loss of 3.2 kg/cm^2, whilst with the new construction the flow rate after the same period was still 4.2 m^3/hour at a pressure loss of only 2.5 kg/cm^2. Hence, with the invention, not only the quantity throughput, but also the times for which the filter may be operated without cleaning are substantially improved.

The resulting improved behaviour of a filter equipped with a filter supporting element according to the invention can be substantially explained as follows. It has been found that the full filter efficiency, which can always be achieved even with higher filtering velocities and pressures in a folded filter bag whose folds are not spread, is limited by a certain maximum size of this fold. This efficiency varies with the nature of the material of the filter bag. With coarse yarn structure and consequently a rough surface of the filter medium, the distances between adjacent unspread folds and hence between adjacent spreading means which are vertically positioned in a filter of the known construction may be larger than with a filter medium having a fine and smooth structure. With an assumed maximum fold spacing of, say, 30 mm length between adjacent spreading means, the unspread fold has its inner surfaces only apparently pressed against each other and the unobstructed outflow of the filtrate is still possible without additional spreading.

The application of this knowledge to the vertical strips of the filter bag, located in known constructions between vertical spreading means shows that such a vertical strip may suitably have a width of, say, not more than 30 millimetres. However, in the known construction, this strip extends from the lower to the upper side of the frame. In the arrangement according to the invention owing to the transverse positioning of the spreading means, the unspread length of these strips is, for example, always only 30 millimetres in the main direction of flow of the filtrate. These short strips offer no noticeable obstruction to the flow and terminate in the main direction of flow always in the spreading means which are permeable, so that there results a substantially smaller flow resistance.

Although there is known in the art a frame-shaped, foldable filter supporting element, having between the two vertical side stays horizontally extending stiffening rods which are also transverse of the main filtrate flow, these stiffening rods are rigid solid structures and the known arrangement does not produce the effect of the present invention.

A particular embodiment of the invention comprises a filter supporting element with a rectangular frame in which the hinges on the filtrate discharge side and on the opposite side of the frame, for connecting these sides to the vertical frame portions, are mutually offset. According to the invention, the spreading means are so arranged that they extend in the unfolded element parallel to the imaginary connecting line between the offset hinge points or even more inclined relative to the horizontal axis of the filtrate discharge side. Accordingly, compared with the horizontal distance between the vertical frame portions on which they are mounted, the spreading means have a longer length so that the filter supporting element may be freely expanded and collapsed. This would not be possible, if the spreading means extended parallel to the horizontal parts of the frame, because during the folding of the frame, owing to the offset arrangement of the hinge points, the distance between the mounting points of the spreading means would increase and the spreading means could not follow this movement. This increase in the distance is taken up by the oblique arrangement of the spreading means according to the invention.

According to another feature of the invention, additional spreading means are arranged in the corners left free by the oblique spreading means, and their ends are connected to the frame of the filter element and to the nearest spreading means. The invention may also be such that one or more vertically positioned auxiliary spreading means are located between the filtrate discharge side of the frame and the main spreading means and between individual main spreading means, having the same or a smaller diameter than the main spreading means and articulately connected thereto, so that the main spreading means are retained additionally in their spread state. According to the invention, these auxiliary spreading means are subdivided into sections having a length corresponding to the distance between and connecting the main spreading means. These individual sections are staggered from one pair of main spreading means to the next. Thus, during the

collapsing of the element, only these short sections collapse between the main spreading means which does not impair the foldability of the element.

The invention will be further described, by way of example, with reference to the accompanying drawing, in which:—

Fig. 1 shows a filter supporting element according to the invention in its expanded position;

Fig. 2 shows the filter supporting element of Fig. 1 in its collapsed position and a filter bag for fitting over the said element;

Fig. 3 shows the expanded filter supporting element covered by a folded filter bag.

The filter supporting element shown in the drawing consists of a substantially rectangular, foldable or collapsible frame 4 with horizontal frame members 41, 42 and vertical frame sides 43, 44. The frame part 41 forms a substantially semi-cylindrical discharge channel for the filtrate, terminating in a co-axial discharge pipe 5. Of the hinges 45, 46, 47 and 48 connecting parts of the frame 4 only 46 and 47 are the true corners of the frame, whilst the hinges 45 and 48 are offset from the corners. Hence, when the frame is folded, a certain space remains between the frame sides 41, 44 and 43, 42.

Between the vertical frame parts 43 and 44, there are spreading means 6 in the form of non-elastic chains, having in the embodiment of the drawing the same inclination relative to the liquid discharge frame part 41 as the imaginary connecting line 7 between the hinge points 45 and 46 or similarly between 47 and 48. Additional spreading means 8 are arranged in the two corners unoccupied by the spreading means 6 and their ends are connected to one vertical side of the frame and to the nearest spreading means. Fig. 1 also shows spreaders 9 which may consist of individual chain links or a plurality thereof which are always connected articulately to two adjacent spreading means 6 or between one spreading means 6 and the filtrate discharge 41. Spreaders 9 in one row are staggered with respect to those in the next row as shown in Figure 1.

After the collapsing of the filter supporting element (Fig. 2), the same is introduced through a comparatively narrow sleeve 101 into a filter bag 10 and is then again expanded inside the bag (Fig. 3). The sleeve 101 is sealed on the conduit leading to the tube 5.

The finished filter shown in Fig. 3 is fitted into a container. The filtering is effected with this filter from the outside towards the inside. Within the filter, the filtrate flows mainly in the direction of the arrow A (Fig. 1) so that in this arrangement the main spreading means 6 are located obliquely to the main direction of flow A. If, at high filtering velocities and pressures, the front and rear sides of the filter bag are pressed towards each other, the sides of the filter bag 10 approach each other between the spreading means only to a limited extent and leave gaps transverse to the direction of flow as shown by A and this offers, as already described, no or only negligible resistance to the flow of the filtrate.

WHAT I CLAIM IS:—

1. A foldable frame-shaped supporting element, adapted for location inside a flexible filter-bag, comprising a four-sided collapsible frame whose sides are hinged together, with elongated spreading means, which allow passage of filtrate therethrough, extending between two opposite sides of the frame, wherein one side of the frame is in the form of a channel-like extension of an outlet pipe for discharge of the filtered liquid and the spreading means extend parallel to or at an angle of up to 45° to the said one side.

2. A filter supporting element as claimed in claim 1, in which the frame is rectangular in shape, and one of the hinges joining the said one side to an adjacent side and the hinge diagonally opposite this hinge are offset with respect to the true geometrical corners of the frame, and the spreading means extend parallel to an imaginary line joining the two hinge points on the said one side or are inclined at a greater angle to the general length of said one side than this imaginary line.

3. A filter supporting element as claimed in claim 2 in which additional spreading means are arranged at the two corners of the frame unoccupied by the first mentioned spreading means and their ends are connected to two sides of the frame and to the adjacent spreading means.

4. A filter supporting element as claimed in any preceding claim in which there are arranged between the said one side and adjacent spreading means and between each pair of adjacent spreading means, additional sections of spreading means, of which the upper sections are connected to the said one side, and the adjacent spreading means, and further sections extend vertically between each adjacent pair of spreading means.

5. A filter supporting element as claimed in Claim 4 in which the additional sections of spreading means are staggered laterally from one row between adjacent spreading means to the next, when the element is expanded.

6. A filter supporting element substan-

tially as hereinbefore described, with reference to, and as illustrated in the accompanying drawings.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1

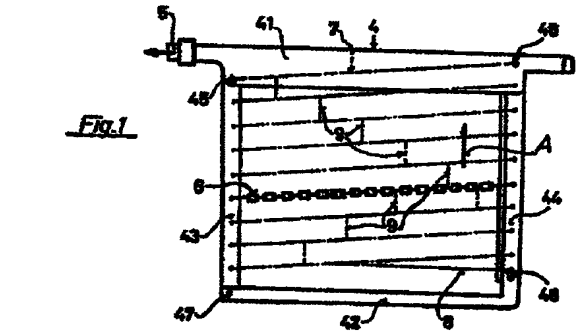

Fig.2

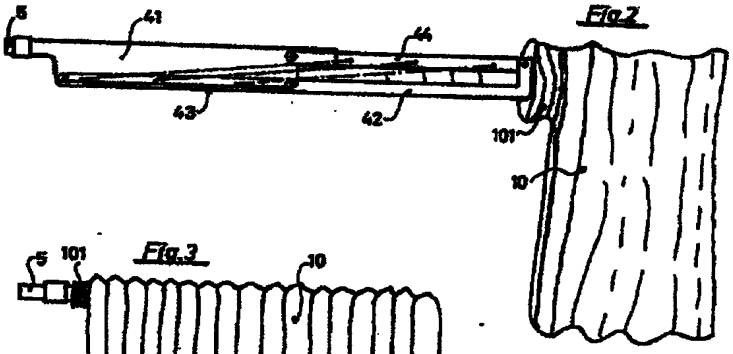

Fig.3